

What is claimed is:

1. An electrolytic processing apparatus, comprising:
an electrode section including a plurality of electrode
5 members disposed in parallel, each electrode member comprising
an electrode and an ion exchanger covering the surface of the
electrode;
a holder for holding a workpiece, which is capable of
bringing the workpiece close to or into contact with the ion
10 exchanger of the electrode member; and
a power source to be connected to the electrode of each
electrode member of the electrode section,
wherein the ion exchanger of the electrode member comprises
an ion exchanger having an excellent surface smoothness and an
15 ion exchanger having a large ion exchange capacity.
2. The electrolytic processing apparatus according to
claim 1, wherein a through-hole for supplying a fluid to the
ion exchanger is formed in the electrode of each electrode member
20 of the electrode section.
3. The electrolytic processing apparatus according to
claim 1, wherein the electrodes of the adjacent electrode members
are connected alternately to the cathode and to the anode of
25 the power source.

4. An electrolytic processing apparatus, comprising:
an electrode section including a plurality of electrode
members disposed in parallel, each electrode member comprising
an electrode and an ion exchanger covering the surface of the
5 electrode;

a holder for holding a workpiece, which is capable of
bringing the workpiece close to or into contact with the ion
exchanger of the electrode member;

a power source to be connected to the electrode of each
10 electrode member of the electrode section, and

a fluid supply nozzle for supplying a fluid between the
workpiece and the ion exchanger of each electrode member.

5. The electrolytic processing apparatus according to
15 claim 4, wherein the fluid supply nozzle has a jet orifice for
jetting the fluid toward the to-be-processed surface of the
workpiece facing the electrode member.

6. The electrolytic processing apparatus according to
20 claim 4, wherein the height of the fluid supply nozzle is lower
than the height of the ion exchanger of the electrode member.

7. The electrolytic processing apparatus according to
claim 4, wherein a through-hole for supplying a fluid to the
25 ion exchanger is formed in the electrode of each electrode member
of the electrode section.

8. The electrolytic processing apparatus according to claim 4, wherein the electrodes of the adjacent electrode members are connected alternately to the cathode and to the anode of the power source.

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9. An electrolytic processing apparatus comprising an electrode member, said electrode member comprising an electrode and an ion exchanger covering the surface of the electrode, wherein a contact width restriction section is provided in said electrode member for restricting the substantial contact width between a workpiece and such a portion of the ion exchanger as usable in processing to a constant width when the workpiece is brought into contact with the ion exchanger of said electrode member to a certain extent of pressing or higher.

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10. The electrolytic processing apparatus according to claim 9, wherein the contact width restriction section is comprised of an insulating film attached to the front surface side or the back surface side of the ion exchanger.

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11. The electrolytic processing apparatus according to claim 9, wherein the contact width restriction section is comprised of a member having no ion exchange ability.

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12. The electrolytic processing apparatus according to claim 11, wherein the member having no ion exchange ability is formed integrally with the ion exchanger.

13. The electrolytic processing apparatus according to claim 9, wherein the contact width restriction section is comprised of a convex portion provided in the ion exchanger.

5 14. The electrolytic processing apparatus according to claim 9, wherein a plurality of said electrode members are disposed in parallel.

15 15. The electrolytic processing apparatus according to claim 14, wherein the electrodes of the adjacent electrode members are connected alternately to the cathode and to the anode of a power source.

15 16. An electrolytic processing apparatus, comprising:
an electrode section including a plurality of feeding electrodes and a plurality of processing electrodes;

20 a holder for holding a workpiece, which is capable of bringing the workpiece close to or into contact with the feeding electrodes and the processing electrodes of the electrode section;

a power source to be connected to each of the feeding electrodes and the processing electrodes of the electrode section; and

25 a drive mechanism for causing a relative movement between the electrode section and the workpiece,

wherein a through-hole is formed in each of the feeding electrodes and the processing electrodes for supplying a fluid to the surface of each of the feeding electrodes and the processing electrodes.

17. The electrolytic processing apparatus according to claim 16, wherein a fluid supply nozzle for supplying a fluid between the workpiece and the feeding electrodes, the processing electrodes is disposed between each feeding electrode and each processing electrode.

18. An electrolytic processing apparatus, comprising:
an electrode section including feeding electrodes and processing electrodes disposed alternately and in parallel;
a holder for holding a workpiece, which is capable of bringing the workpiece close to or into contact with the feeding electrodes and the processing electrodes of the electrode section;
a power source to be connected to each of the feeding electrodes and the processing electrodes of the electrode section;
a drive mechanism for causing a relative movement between the electrode section and the workpiece; and
a liquid supply section for supplying a liquid between the feeding electrodes, the processing electrodes and the workpiece.

19. The electrolytic processing apparatus according to claim 18, wherein an ion exchanger is provided between the feeding electrodes, the processing electrodes and the workpiece.

20. A substrate processing apparatus, comprising:
a substrate carry-in-and-out section for carrying in and
out a substrate;
an electrolytic processing apparatus; and
5 a transfer device for transferring the substrate between
the substrate carry-in-and-out section and the electrolytic
processing apparatus, wherein the electrolytic processing
apparatus comprises:
(i) an electrode section including a plurality of electrode
10 members disposed in parallel, each electrode member comprising
an electrode and an ion exchanger covering the surface of the
electrode;
(ii) a holder for holding the substrate, which is capable
of bringing the substrate close to or into contact with the ion
15 exchanger of the electrode member; and
(iii) a power source to be connected to the electrode of
each electrode member of the electrode section,
wherein the ion exchanger of the electrode member comprises
an ion exchanger having an excellent surface smoothness and an
20 ion exchanger having a large ion exchange capacity.

21. A substrate processing apparatus, comprising:
a substrate carry-in-and-out section for carrying in and
out a substrate;
25 an electrolytic processing apparatus; and
a transfer device for transferring the substrate between
the substrate carry-in-and-out section and the electrolytic
processing apparatus, wherein the electrolytic processing
apparatus comprises:

(i) an electrode section including a plurality of feeding electrodes and a plurality of processing electrodes;

(ii) a substrate holder for holding the substrate, which is capable of bringing the substrate close to or into contact
5 with the electrode section;

(iii) a power source to be connected to each of the electrodes of the electrode section; and

(iv) a drive mechanism for causing a relative movement between the electrode section and the substrate,

10 wherein a through-hole is formed in each of the feeding electrodes and the processing electrodes for supplying a fluid to the surface of each of the feeding electrodes and the processing electrodes.

15 22. A substrate processing apparatus, comprising:

a substrate carry-in-and-out section for carrying in and out a substrate;

an electrolytic processing apparatus; and

a transfer device for transferring the substrate between
20 the substrate carry-in-and-out section and the electrolytic processing apparatus, wherein the electrolytic processing apparatus comprises:

(i) an electrode section including a plurality of feeding electrodes and a plurality of processing electrodes;

25 (ii) a substrate holder for holding the substrate, which is capable of bringing the substrate close to or into contact with the electrode section;

(iii) a power source to be connected to each of the electrodes of the electrode section;

(iv) a drive mechanism for causing a relative movement between the electrode section and the substrate; and

(v) a processing liquid supply mechanism for supplying a processing liquid between the substrate and the electrode
5 section.

23. An electrolytic processing method for electrolytically processing the surface of a workpiece, comprising:

bringing the workpiece into contact with a processing
10 electrode, said processing electrode having an ion exchanger disposed on its surface and having a narrower width than the workpiece; and

processing the surface of the workpiece while allowing the processing electrode and the workpiece to make a relative
15 movement,

wherein the substantial contact width between the workpiece and such a portion of the ion exchanger as used in processing is kept constant during the processing.

20 24. The electrolytic processing method according to claim 23, wherein at least the portion of the ion exchanger exposed on the surface of the processing electrode is brought into a substantial contact with the workpiece over the full width of the exposed portion.

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25. An electrolytic processing method, comprising:

bringing a workpiece close to or into contact with a processing electrode;

applying a voltage between the processing electrode and a feeding electrode that feeds electricity to the workpiece; supplying a fluid between the workpiece and at least one of the processing electrode and the feeding electrode; and
5 processing the surface of the workpiece while allowing the processing electrode and the workpiece to make a first relative movement, which is a relative reciprocating movement in a certain direction, and, at the same time, allowing the workpiece and the processing electrode to make a second relative movement,
10 which is a relative movement in said certain direction for a distance corresponding to an integral multiple of a pitch as determined in the processing amount distribution of the workpiece in said direction, obtained in the first relative movement.

15 26. The electrolytic processing method according to claim 25, wherein the speed of the first relative movement is changed.

27. The electrolytic processing method according to claim 25, wherein the processing electrode is comprised of a plurality
20 of electrode members disposed in parallel, each electrode member comprising an electrode and an ion exchanger covering the surface of the electrode.

28. The electrolytic processing method according to claim
25 25, wherein the second relative movement is a reciprocating movement.

29. The electrolytic processing method according to claim 28, wherein the moving distance in the reciprocating movement of the second relative movement differs between the forward movement and the backward movement.

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30. The electrolytic processing method according to claim 28, wherein the second relative movement is repeated, and the moving direction of the workpiece in the second relative movement is changed with the movement in said certain direction in the
10 second relative movement as a unit.

31. The electrolytic processing method according to claim 25, wherein the voltage and/or electric current applied between the processing electrode and the feeding electrode is changed
15 during electrolytic processing.

32. The electrolytic processing method according to claim 25, wherein the speed of the second relative movement is changed during electrolytic processing.

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33. An electrolytic processing method, comprising:
bringing a workpiece close to or into contact with a processing electrode;
applying a voltage between the processing electrode and
25 a feeding electrode that feeds electricity to the workpiece;
supplying a fluid between the workpiece and at least one of the processing electrode and the feeding electrode; and

processing the surface of the workpiece while allowing the processing electrode and the workpiece to make a first relative movement and, at the same time, allowing the workpiece and the processing electrode to make a second relative movement in a certain direction, wherein the second relative movement is repeated, and the moving direction of the workpiece in the second relative movement is changed with the movement in said certain direction in the second relative movement as a unit.

10 34. The electrolytic processing method according to claim 33, wherein the speed of the first relative movement is changed.

35. The electrolytic processing method according to claim 33, wherein the workpiece is rotated through a predetermined rotational angle so as to change the moving direction of the workpiece in the second relative movement.

36. The electrolytic processing method according to claim 35, wherein the rotation of predetermined rotational angle is repeated so that the workpiece makes at least one revolution until completion of the electrolytic processing of the workpiece.

37. The electrolytic processing method according to claim 33, wherein the position of the workpiece relative to the processing electrode in the second relative movement is changed with the movement in said certain direction in the second relative movement as a unit.

38. The electrolytic processing method according to claim 33, wherein the workpiece is not rotated during the second relative movement.

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39. The electrolytic processing method according to claim 33, wherein the voltage and/or electric current applied between the processing electrode and the feeding electrode is changed during electrolytic processing.

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40. The electrolytic processing method according to claim 33, wherein the speed of the second relative movement is changed during electrolytic processing.

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41. An electrolytic processing apparatus, comprising:
a processing electrode that can come close to or into contact with a workpiece;

a feeding electrode for feeding electricity to the workpiece;

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a holder for holding the workpiece and bringing the workpiece close to or into contact with the processing electrode;

a plurality of ion exchangers disposed between the workpiece and at least one of the processing electrode and the feeding electrode; and

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a feed mechanism for feeding and changing at least one of the plurality of ion exchangers.

42. The electrolytic processing apparatus according to claim 41, wherein a plurality of feed mechanisms, each for each of the plurality of ion exchangers, are provided.

5 43. The electrolytic processing apparatus according to claim 41, wherein the change cycle of an ion exchanger that does not come close to or into contact with the workpiece is shorter than the change cycle of an ion exchanger that comes close to or into contact with the workpiece.

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44. The electrolytic processing apparatus according to claim 43, wherein the ion exchanger that does not come close to or into contact with the workpiece is changed by the feed mechanism.

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45. The electrolytic processing apparatus according to claim 41, wherein of the plurality of ion exchangers, the change cycle of an ion exchanger having a large ion exchange capacity is shorter than the change cycle of the other ion exchanger(s).

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46. The electrolytic processing apparatus according to claim 41, wherein the change of the ion exchanger(s) is carried out during electrolytic processing.

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47. The electrolytic processing apparatus according to claim 41, including:

a plurality of rotatable members; and

a plurality of intervening members intervening between the rotatable members,

wherein the ion exchangers are disposed such that they threadbetween the rotatable members and the intervening members.

48. The electrolytic processing apparatus according to
5 claim 47, wherein the rotatable member is at least one of the processing electrode and the feeding electrode.

49. The electrolytic processing apparatus according to claim 41, further comprising:
10 a regeneration device for regenerating the ion exchanger that is circulated by the feed mechanism.

50. An electrolytic processing apparatus, comprising:
a processing electrode that can come close to or into contact
15 with a workpiece;
a feeding electrode for feeding electricity to the workpiece;
a holder for holding the workpiece and bringing the workpiece close to or into contact with the processing electrode;
20 an ion exchanger disposed between the workpiece and at least one of the processing electrode and the feeding electrode;
a water-permeable member superimposed on the surface of the ion exchanger; and
a feed mechanism for feeding and changing the ion exchanger.

25 51. The electrolytic processing apparatus according to claim 50, wherein the change cycle of the ion exchangers is shorter than the change cycle of the water-permeable member.

52. The electrolytic processing apparatus according to claim 50, including:

a plurality of rotatable members; and

5 a plurality of intervening members intervening between the rotatable members,

wherein the ion exchanger is disposed such that it threads between the rotatable members and the intervening members.

10 53. The electrolytic processing apparatus according to claim 50, wherein the rotatable member is at least one of the processing electrode and the feeding electrode.

54. The electrolytic processing apparatus according to claim 50, further comprising:

a regeneration device for regenerating the ion exchanger that is circulated by the feed mechanism.

55. An electrolytic processing apparatus, comprising:
20 a processing electrode that can come close to or into contact with a workpiece;

a feeding electrode for feeding electricity to the workpiece; and

a holder for holding the workpiece and bringing the
25 workpiece close to or into contact with the processing electrode,

wherein the processing electrode or the feeding electrode is comprised of a plurality of electrodes, and the respective electrodes can move close to or apart from the workpiece independently.

56. The electrolytic processing apparatus according to claim 55, wherein an ion exchanger is disposed between the workpiece and at least one of the processing electrode and the feeding electrode.

57. A substrate holder for holding a substrate and bringing the substrate into contact with a processing electrode to carry out electrolytic processing of the substrate, comprising:
10 a flange portion connected to a shaft; and
 a chucking member which can move with respect to the flange portion in the axial direction of the shaft and which holds the substrate.

58. The substrate holder according to claim 57, further comprising:
 a first pressure chamber formed between the flange portion and the chucking member,
 wherein a fluid is supplied to the first pressure chamber
20 to pressurize the first pressure chamber, thereby bringing the substrate held by the chucking member into contact with the processing electrode.

59. The substrate holder according to claim 58, wherein
25 the first pressure chamber is defined by the flange portion, the chucking member, and an elastic member linking the flange portion and the chucking member.

60. The substrate holder according to claim 57, wherein a weight of a predetermined weight is attached to the chucking member to adjust the pressure of the substrate to the processing electrode.

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61. The substrate holder according to claim 57, further comprising:

an air cylinder for pressing the chucking member downward.

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62. The substrate holder according to claim 57, the chucking member including:

a chucking plate having a through-hole communicating with the substrate;

a stopper plate provided above the chucking plate; and

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a second pressure chamber formed between the chucking plate and the stopper plate,

wherein the second pressure chamber is depressurized by drawing a fluid from the second pressure chamber, thereby attracting the substrate to the chucking member.

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63. The substrate holder according to claim 57, wherein a retainer ring having an inward-protruding portion is mounted to the flange portion, and a protrusion for engaging the protruding portion of the retainer ring are provided in the chucking member.

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64. An electrolytic processing apparatus, comprising:

a processing electrode;

a feeding electrode for feeding electricity to a substrate;

a substrate holder for holding the substrate and bringing the substrate into contact with the processing electrode;

a power source for applying a voltage between the processing electrode and the feeding electrode; and

5 a drive section for allowing the substrate held by the substrate holder and the processing electrode to make a relative movement,

wherein the substrate holder is a substrate holder for holding the substrate and bringing the substrate into contact
10 with the processing electrode to carry out electrolytic processing of the substrate and comprises: a flange portion connected to a shaft; and a chucking member which can move with respect to the flange portion in the axial direction of the shaft and which holds the substrate.

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65. The electrolytic processing apparatus according to claim 64, wherein an ion exchanger is disposed between the substrate and at least one of the processing electrode and the feeding electrode.

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66. The electrolytic processing apparatus according to claim 65, further comprising:

a fluid supply section for supplying a fluid between the substrate and at least one of the processing electrode and the
25 feeding electrode in which the ion exchanger is disposed.

67. The electrolytic processing apparatus according to claim 64, wherein a water-permeable member is disposed between

the substrate and at least one of the processing electrode and the feeding electrode.

68. An electrolytic processing method, comprising:
5 providing a processing electrode and a feeding electrode;
applying a voltage between the processing electrode and the feeding electrode;

holding a substrate by a substrate holder, said substrate holder including a flange portion connected a shaft and a chucking
10 member for holding the substrate; and

allowing the substrate to be in contact with the processing electrode while allowing the substrate and the processing electrode to make a relative movement, thereby processing the surface of the substrate.

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69. The electrolytic processing method according to claim 68, including:

supplying a fluid to a first pressure chamber formed between the flange portion and the chucking member of the substrate holder
20 to pressurize the first pressure chamber, thereby bringing the substrate held by the chucking member into contact with the processing electrode.

70. The electrolytic processing method according to claim
25 68, wherein an ion exchanger is disposed between the substrate and at least one of the processing electrode and the feeding electrode.

71. The electrolytic processing method according to claim 69, wherein the pressure of the fluid supplied to the first pressure chamber is adjusted so that the pressure applied to the substrate becomes not more than 6.86 kPa.

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72. An electrolytic processing apparatus, comprising:
an electrode section including a plurality of electrode members disposed in parallel, each electrode member comprising an electrode and a processing member mounted on the surface of
10 the electrode;

a holder for holding a workpiece, which is capable of bringing the workpiece close to or into contact with the processing member of the electrode member; and

a power source to be connected to the electrode of each
15 electrode member of the electrode section,

wherein contact members that contact the surface of the workpiece are disposed between the plurality of electrode members.

20 73. The electrolytic processing apparatus according to claim 72, wherein a buffer member formed of a material having such an elasticity as not damage the surface of the workpiece is mounted on each contact member.

25 74. The electrolytic processing apparatus according to claim 72, wherein the processing member comprises an ion exchanger.

75. An electrolytic processing apparatus, comprising:
a processing electrode;
a feeding electrode for feeding electricity to a substrate;
a substrate holder for holding the substrate and bringing
5 the substrate close to or into contact with the processing
electrode and the feeding electrode;
a power source for applying a voltage between the processing
electrode and the feeding electrode;
a drive section for allowing the substrate held by the
10 substrate holder, and the processing electrode and feeding
electrode to make a relative movement;
a fluid supply section for supplying a fluid between the
substrate and at least one of the processing electrode and the
feeding electrode; and
15 a partition for at least partly separating the flow of the
fluid between the processing electrode and the substrate from
the flow of the fluid between the feeding electrode and the
substrate.
- 20 76. The electrolytic processing apparatus according to
claim 75, wherein an ion exchanger is disposed between the
substrate and at least one of the processing electrode and the
feeding electrode.
- 25 77. The electrolytic processing apparatus according to
claim 75, wherein the partition is formed of an elastic material.

78. The electrolytic processing apparatus according to claim 77, wherein the elastic material is a nonwoven fabric, a foamed polyurethane, a PVA sponge, a polyurethane sponge, or an ion exchanger.

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79. The electrolytic processing apparatus according to claim 75, further comprising:

a second partition for separating the flow of the fluid, flowing in the region isolated by adjacent said partitions, into
10 a flow on the processing electrode or feeding electrode side and a flow on the workpiece side.

80. The electrolytic processing apparatus according to claim 75, wherein the fluid is ultrapure water, pure water, a
15 liquid having an electric conductivity of not more than 500 $\mu\text{S}/\text{cm}$, or an electrolysis solution.

81. The electrolytic processing apparatus according to claim 75, including:

20 a fluid suction section for sucking in the fluid flowing in the region isolated by adjacent said partitions.

82. An electrolytic processing apparatus, comprising:
an electrode section including a plurality of electrodes;

25 a holder for holding a workpiece, which is capable of bringing the workpiece close to or into contact with the electrodes; and

a power source to be connected to each electrode of the electrode section,

wherein contact members that contact the surface of the workpiece are disposed between the plurality of electrodes.

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83. An electrolytic processing method comprising:
providing a processing electrode and a feeding electrode;
applying a voltage between the processing electrode and the feeding electrode;

10 bringing a workpiece close to or into contact with the processing electrode; and

processing the surface of the workpiece while allowing the workpiece and the processing electrode to make a relative movement,

15 wherein the flow of a fluid between the processing electrode and the workpiece is at least partly separated from the flow of the fluid between the feeding electrode and the workpiece.

84. The electrolytic processing method according to claim
20 83, wherein an ion exchanger is disposed between the workpiece and at least one of the processing electrode and the feeding electrode.